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ABSTRACT

Role-specific self-concept was assessed in 357 geometry students in Utah and North Carolina and analyzed in a causal-comparative study of the influences of success (geometry letter grade from previous semester), teacher, and sex of student. Research literature suggests that variations in self-concept might be expected as a result of, or from interaction with, these independent variables. Self-concept was assessed as a rank order correlation coefficient of two Q-sorts (ideal mathematics student, actual self) of 24 student descriptor items. Success and teacher were found to be statistically significant influences; sex was not. No interactions were found to be significant. The three independent variables accounted for 19.5% of the observed variance in self-concept scores. The results confirm previous findings about the role of success in learning, have implications for teacher recruitment and performance, and raise questions about sex differences in mathematics education. (Author)

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GEOMETRY STUDENTS' ROLE-SPECIFIC SELF-CONCEPT: SUCCESS, TEACHER, AND SEX DIFFERENCES

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RUNNING HEAD: GEOMETRY SELF-CONCEPT

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Abstract

Role-specific self-concept was assessed in 357 geometry students in Utah and North Carolina and analyzed in a causal-comparative study of the influences of success (geometry letter grade from previous semester), teacher, and sex of student. Research literature suggests that variations in self-concept might be expected as a result of, or from interaction with, these independent variables. Self-concept was assessed as a rank order correlation coefficient of two Q-sorts (ideal mathematics student, actual self) of 24 student descriptor items. Success and teacher were found to be statistically significant influences; sex was not. No interactions were found to be significant. The three independent variables accounted for 19.5% of the observed variance in self-concept scores. The results confirm previous findings about the role of success in learning, have implications for teacher recruitment and performance, and raise questions about sex differences in mathematics education.

Geometry Students' Role-Specific Self-Concept: Success, Teacher, and Sex Differences

Students' self-concept as it relates to their participation in subject matter classes is of interest to mathematics educators and researchers as a primary educational objective and as an indirect indicator of program quality. Student self-concept also is important in understanding the dynamics of other features of classroom learning, for example, the interaction of success and self-image, interactions between student perceptions and teacher behaviors, and influences of students' sex on participation and learning. Self-concept has been shown to operate with some independence in various parts or roles of a person's life, such as school, work, relationships, family life, and religion, as opposed to being a single dominating global factor (Bilby, Brookover & Erikson, 1972). Therefore, it is of interest to educators to focus on role-specific self-concept--in this study in the role of a mathematics student. Many factors contribute to, or are affected by, a person' self-concept. Three factors which are of particular interest in understanding self-concept in school settings are academic success, teachers, and sex of student.

Student self-concept is an important consideration because it is substantially related to academic achievement (Brookover, Thomas & Patterson, 1964; Coleman, 1966; Brookover, Erikson & Joiner, 1967; Purkey, 1978; Burns, 1979). In the 1967 Brookover et al. study the correlation between self-concept of ability and GPA ranged between 0.48 to 0.63 for each of the last six years of public school. Peterson, Kauchak & Yaakobi (1980) reported that letter grades accounted for 21% of the observed variance in their study of high school science students' role-specific self-concept. The association of positive self-concept with academic achievement has been found to be true in mathematics (Starr, 1975; Raven & Adrian, 1978; Kremer & Walber, 1981). Causation patterns for this relationship

are not clear in all students; whether the feelings or behavior come first (or, more likely, interact) may be an individual characteristic (Scheirer & Kraut, 1979).

Findings from personality research suggest that self-concept may play an important role in the dynamics of mathematical learning and performance. Hamachek (1972) reported that persons with high self-concept act with confidence on their own best judgment without feeling guilty, resist domination by others, defend their values even in the face of group opposition, and can acknowledge mistakes without feeling overwhelmed. Irwin (1967) gave evidence that persons with high self-esteem are less dependent on external reinforcement. Positive self-concept is desirable in mathematics where, as described by Rossi (1972), there is evidence that the high achiever must be independent, able to handle apartness from others without guilt or longing, and to channel energy intensively in one direction.

Teacher influence on student self-concept is significant (Covington & Beery, 1976; Purkey, 1978; Burns, 1979). Simpson (1978), in a summary of research in attitudes and achievement in science education, concluded that the teacher was one of the most important contributors to student achievement and attitudes. He suggested that teacher expectations, interactions with students, and feelings about students all affected student confidence in performance. Peterson & Yaakobi (1980) reported a correlation of 0.41 between teachers' self-reported, role-specific self-concept and the corresponding values for their students. Schofield (1981) found the influence of mathematics teachers on achievement and attitude to be substantial.

One specific influence that teachers can have on their pupils is differential treatment of females and males as mathematics students, particularly in regard to expectations for performance, attitude, and continued enrollment. It has been found that teachers in high school mathematics classes pay more attention to males

(Brophy & Good, 1970) and that they are more apt to refer male students for enrichment and for remedial assistance (Gregory, 1977). However, when females are expected by teachers to learn mathematics, they do (Casserly, 1975). Ernest (1976) and Levine (1976) concluded that a significant number of teachers believe males to be the more capable sex in mathematics. Casserly (1975) found that many young women gifted in mathematics had been counseled out of nonrequired mathematics courses on the grounds that these courses were not necessary for their future and that by taking them they risked spoiling their academic records and/or that in taking such courses their senior year would not be as much fun. Luchins (1976) reported that many female mathematicians recall similar experiences. Since high expectancy of success and high self-concept correlate with continued course-taking (Parsons, 1980), the views and advice of teachers can be very influential.

Specific differences between females and males have been found in mathematics students both in participation and levels of achievement in mathematics classes. Among the established findings in this area are: (1) While differences between male and female performance are slight during elementary school, male performance exceeds that of females at the secondary and post-secondary levels (Maccoby & Jacklin, 1974; Fennema & Sherman, 1977); (2) males traditionally take more mathematics courses than females once course-taking is left to student choice (Casserly, 1975); (3) there are more males among the highest achievers in mathematics (Benbow & Stanley, 1980); (4) spatial ability differences appear to favor males (McGee, 1979); (5) the major factor in predicting continued taking of mathematics courses is subjective evaluation of the usefulness of the subject, followed by confidence (Armstrong & Price, 1982); (6) female confidence in mathematics is significantly lower than that of males (Wooleat, Pedro, Becker, & Fennema, 1980); (7) females, to a greater degree than males, believe that mathematics

will play only a small part in their lives (Burton, 1979); and, (8) sex differences in mathematics achievement are related to school affective climate (Sherman & Fennema, 1977).

Ideal-actual discrepancy Q-sorts have been used to assess teachers in their helper role (Tyler, 1964), quality of nursing programs (Stone & Green, 1971), adolescent self-concept for program evaluation (Lee, 1972), and science student self-concept (Peterson & Yaakobi, 1979; Peterson, Kauchak, & Yaakobi, 1980).

Peterson et al. (1980) used a double Q-sort instrument to study influences on high school science students' self-concept. The dependent variable for the study was the rank order correlation coefficient between sorts; dependent variables were course (general science, biology, or physics), letter grade received in course the previous semester, and sex of student. Test-retest reliability for the instrument was 0.87. Significant differences in role specific self-concept were found according to success (0.42 linear correlation); but no significant differences were found according to course or sex.

The purpose of this study was to estimate the influence of success, teacher, and sex of student on mathematics self-concept of high school geometry students. Previous studies suggest a strong link between self-concept and success, even on measures which are not role-specific. Less empirical evidence exists for the contention that teachers make a difference in student academic-related self-concept. Finally, since differences in student sex have shown up in a number of achievement and qualitative inquiries, one goal of this study was to detect differences in role-specific math student self-concept attributable to sex.

Method

Questions

Major questions addressed in this study were: Are there statistically significant differences in role-specific self-concept of geometry students according to

success (letter grade), teacher, and sex of students? What are the individual and combined influences of these variables?

Sample

The study sample consisted of 357 ninth and tenth grade geometry students from North Carolina (N = 195) and Utah (N = 162) public schools which were selected to generally represent local student populations. North Carolina students represented a middle to lower class SES group. Utah students were middle to upper middle class. The sample was 83.2% white, 15.3% black, and 1.5% other. The total included 171 females and 186 males. Geometry letter grades in the previous semester had a mean of 2.71 (SD 1.15) on a 4-point scale. The sexes did not differ with statistical significance on either mean grade ($t = .27$; $df = 355$; $p = .79$) or grade distribution ($\chi^2 = 1.17$; $df = 4$; $p = .88$). Students participated as volunteers during class time; less than 1% declined, and absentees were not included.

Subjects were enrolled in one of 17 classes taught by seven teachers (six male, one female). Teachers were not identified as unusual instructors for their schools, and volunteered for the study. Mean class participation size was 21.0 (SD 4.80); absentees and unusable data sets mean that classes were actually larger. Each teacher, except one, was represented by more than one class. Mean grades given by teachers in this study did vary with statistical significance ($F = 15.71$; $df = 6,351$; $p<.01$).

Instrument

Self-concept data were gathered with a double Q-sort of mathematics student behavior and attitude descriptors. While there is much discussion about the nature of self-concept and its measurement (Burns, 1979), the operational definition for this study was the extent to which a subject described themselves in their own ideal terms (Peterson & Yaakobi, 1979). Students first sorted the items to describe an ideal mathematics student and then to describe their own behavior. The

self-concept score was computed as a rank order correlation coefficient (Spearman's rho) between the two sorts; possible scores ranged from +1.00 to -1.00. The sort consisted of 24 mathematics student items such as "Enjoys working alone on difficult math problems," "Memorizes formulas and proofs even when s/he does not understand them," "Thinks up original problems," "Volunteers to take part in class discussions," "Does not always do as the teacher directs," and "Passes in papers which are neat and clean." Test-retest reliability for the instrument was found to be 0.92 for a subset of the study sample.

Data and Analysis

The dependent variable of this study was a role-specific self-concept score. Independent variables were letter grades received from first semester of geometry (success), teacher identification number, and sex of student. The student was the unit of analysis. Data were collected during the first month of the second semester.

Analysis consisted of a three-way analysis of variance (ANOVA) and a Multiple Classification Analysis (MCA). The ANOVA provided a significance test for main effects and each independent variable. The MCA provided a breakdown of numbers, mean scores by variable, partial correlation ratio (Beta: a standardized regression coefficient) for each independent variable, multiple correlation (R) for main effects, and percent of observed variance explained by the independents (R^2). Interactions among the three independent variables were not examined due to empty cells: some teachers did not give D and F grades. However, the interactions between teacher and sex, and letter grade and sex were examined using a two-way analysis of covariance (ANCOVA) with grade as a covariate for the former analysis and a two-way ANOVA for the letter.

Results

Results of a three-way ANOVA of teacher, success, and sex on self-concept score are presented in Table 1. The main effects were found to be statistically signifi-

cant. Differences in mean self-concept score by letter grade and teacher were

Insert Table 1 about here

found to be statistically significant ($P<.05$), while sex was not. The relationship between letter grade (adjusted for teacher and sex) and self-concept score is presented in Table 2. The MCA indicated that letter grade was the strongest

Insert Table 2 about here

independent variable, followed by teacher, and then sex. The three variables accounted for 19.5% of the observed variance in self-concept scores.

The two-way ANCOVA of teacher and sex on self-concept score, with letter grade as a covariate, was found not to be statistically significant ($F = .44$; $df = 6,355$; $p = .85$). Likewise, the analysis of interaction between letter grade and sex was found not to be significant ($F = .55$; $df = 4,347$; $p = .70$).

Discussion

High school geometry student self-concept was more affected by past success and teacher than by sex for subjects in this study. The existence of an important relationship between academic achievement and role-specific self-concept, described by many other researchers, was corroborated. This finding lends validity to the analysis of the other variables.

Teacher effects were found to be statistically significant. An implication of these results is that, indeed, teachers do make a difference in classroom quality and learning. This finding is especially important in light of the difficulty schools are having in recruiting and retaining qualified mathematics teachers. It also reinforces the need for upgrading the profession of mathematics

teachers as outlined by such groups as the National Council of Teachers of Mathematics (1980).

While recent discussions of sex differences in mathematics performance and participation suggest differences between males and females, this study found no difference between the sexes in self-concept as a student in geometry. Also, judging by the lack of interaction, it appeared that the sexes did not differ on how grades influenced, or were influenced by, their self-concept. While the structure of the student perceptions was not examined (i.e., specific rankings of items by sex), it must be concluded that males and females, who received similar grades in this sample, perceive similar levels of adequacy about themselves as geometry students. This finding calls into question the contention of some writers that females do not feel as good about themselves as mathematics studens, as do males. It may be the case that the self-concept of females in the study represents an equilibrium between lowered expectations or perceptions of the ideal and of themselves, which is the same as for males. The findings do not answer the questions about why females do not continue to enroll in mathematics classes to the same extent as males, and if the sexes differ in the make-up of the self-perception and ideal-image of mathematics students.

In this study the dependent variables were found to account for 19.5% of the observed variance. This level of explanation is similar to that found in other studies of self-concept and other psychological constructs such as locus of control. The 80% variance unaccounted for may be due to individual differences, influences on self-concept external to mathematics classes, and, of course, measurement errors.

Differences among teachers in differential treatment of the sexes was not found in this study. However, the sample of teachers was small (N = 7); a

larger population of teachers might have shown a wider and more extreme range of patterns of interaction with students.

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TABLE 1

ANALYSIS OF VARIANCE: SELF-CONCEPT BY TEACHER, LETTER GRADE, AND SEX (N=357)

SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F	p
Main Effects	8.52	11	.77	7.62	<.01
Teacher	2.76	6	.46	4.52	<.01
Letter Grade	7.46	4	1.87	18.35	<.01
Sex	.26	1	.26	2.61	.11
Residual	35.08	346	.10		
Total	43.59	357	.12		

MULTIPLE CLASSIFICATION ANALYSIS

GRAND MEAN = .49 (S.D. = .35)

VARIABLE + CATEGORY	N	UNADJUSTED MEAN	UNADJUSTED S.D.	ADJUSTED FOR INDEPENDENTS	BETA
TEACHER					
1	37	.52	.31	.44	
2	42	.44	.35	.42	
3	25	.46	.29	.44	
4	47	.39	.38	.30	
5	43	.53	.34	.53	
6	62	.48	.37	.64	
7	101	.54	.35	.52	.28
GRADE					
F	21	.14	.43	.03	
D	33	.40	.41	.31	
C	72	.40	.40	.40	
B	135	.50	.30	.52	
A	96	.65	.22	.66	.46
SEX					
Female	171	.47	.34	.46	
Male	186	.51	.36	.52	.08
MULTIPLE R	.442				
MULTIPLE R SQUARED	.195				

TABLE 2

SELF-CONCEPT SCORES AND LETTER GRADES

(Adjusted for Teacher and Sex)